Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
RADWIN LTD**.**	)	
	)	
Amendment of Part 15 of the Commission's Rules	)	RM - _____
To Advance Improved Broadband Services	)	
in the U-NII-1 and U-NII-3 Bands	)	

PETITION FOR RULEMAKING

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PETITION FOR RULEMAKING

Pursuant to Section 1.401(a) of the Commission's rules,[1/] RADWIN LTD. ("RADWIN") requests that the FCC modify its rules to allow for the provision of improved broadband services in the U-NII-1 (5.15-5.25 GHz) and U-NII-3 (5.725-5.85 GHz) Unlicensed National Information Infrastructure ("U-NII") bands. The requested modification of the rules is consistent with the Commission's approach in the 2400-2483.5 MHz (the "2.4 GHz") band, and will promote the public interest by allowing for improved and greater access to broadband services, particularly in rural areas.

I. INTRODUCTION AND SUMMARY

RADWIN, established in 1997, is headquartered in Tel Aviv, Israel. RADWIN's U.S. subsidiary, RADWIN Inc., is located in Mahwah, New Jersey.[2/] RADWIN is a leading provider of sub-6 GHz wireless broadband solutions, providing backhaul and fixed access systems to major carriers in the United States and worldwide. RADWIN presently has more than 750,000

1/ 47 C.F.R. § 1.401(a).

2/ RADWIN Inc., a wholly-owned subsidiary of RADWIN, serves as the distributor of RADWIN broadband wireless systems to independent distributors in the U.S. and Canada. In addition, it provides training and post-sales technical support to customers and partners. RADWIN LTD. develops, manufactures, and markets RADWIN products globally.

deployments in more than 150 countries. RADWIN currently manufactures and sells point-to-point and point-to-multi-point products that power applications, including enterprise and residential broadband access, backhaul, private network connectivity, and video surveillance transmission, as well as deliver broadband to rail transportation customers. Among other technologies, certain of its products feature multiple directional beam capabilities.

RADWIN seeks modification of the Commission's rules to permit the provision of improved broadband services using spectrum currently designated for unlicensed operations. In particular, RADWIN seeks modification of Section 15.407 of the rules to allow devices that emit multiple directional beams sequentially in the U-NII-1 and U-NII-3 bands to operate at power limits that are allowed for point-to-point systems in those bands. Devices using sequential multiple directional beam technology are FCC certified and in use today in these U-NII bands, but are subject to power limits established for point-to-multi-point systems operating in these bands. This is different from the regulatory treatment of similar devices with multiple directional beam technology, operating in the 2.4 GHz band, where the rules recognize the unique characteristics of this technology and allow for more robust power limits permitted for point-to-point devices in the same bands.

Devices employing sequential multiple directional beam technology use advanced, phased array antennas and electronic steering capabilities that allow them to sequentially transmit multiple, extremely directional beams to subscriber units. Traditional point-to-multipoint devices with sectorized antennas use very wide beams, which radiate at wider angles, constantly transmitting into the entire sector, creating the potential for more interference to neighboring devices and making them more susceptible to interference from other devices. Devices using electronically steered sequential multiple directional beams have precise control

over the direction of the radiofrequency energy, achieving higher performance (capacity, range, reliability) in the desired direction, while diminishing the potential for creating or receiving harmful interference. This directional connectivity is more spectrum efficient and improves range, reliability and network capacity similar to that of point-to-point systems, which also operate with directional antennas. RADWIN therefore proposes that the same power limit rules would apply to point-to-point devices and point-to-multipoint devices operating with sequential multiple directional beam technology.

Allowing devices that emit sequential multiple directional beams to operate in the U-NII-1 and U-NII-3 bands at power limits that are allowed for point-to-point systems in those bands will benefit the public by supporting the growing needs of businesses and consumers for fixed broadband communications. The technology can provide much higher performance than what can be achieved under the current rules, with improvements in gain, capacity, range and robustness, which extends the reach of a system at a single site with no additional costs. Modification of the rules will therefore enhance service providers' ability to connect more customers from sites they are already using, without incurring additional costs to reach these more distant customers. Service providers also will be able to offer higher throughput and greater overall reliability to those customers. As a result of these improvements and cost savings, broadband service would be improved, especially in rural areas where service would become more economical, facilitating the Commission's goal of improving broadband access, particularly in rural America.

II. DISCUSSION

A. Proposed Amendments to Section 15.407.

Sections 15.247 and 15.407 of the rules contain technical limits for unlicensed broadband devices operating in the 2.4 GHz and U-NII bands, respectively.[3/] Section 15.247 governs the operation of certain digitally modulated unlicensed transmitters operating in 915 MHz, 2.4 GHz, and 5.7 GHz, while Section 15.407 governs unlicensed transmitters operating in the 5 GHz U-NII bands.[4/] Although many of the rules are similar, the Commission modified Section 15.247 several years ago to allow devices that emit multiple directional beams to operate in the 2.4 GHz band at power limits otherwise applicable to point-to-point systems. RADWIN proposes that the same regulatory structure apply to Section 15.407 for U-NII-1 and U-NII-3 band operations.[5/]

The specific wording changes that RADWIN suggests are presented in the attached **Appendix A**. In summary, RADWIN proposes that the Commission:

- Modify Section 15.407(a)(1)(iii) to allow devices in the band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals into individual receivers or groups of receivers to operate under the rules allowed for fixed, point-to-point operations.

- Modify Section 15.407(a)(3) to allow devices in the band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals into individual receivers or groups of receivers to operate under the rules allowed for fixed, point-to-point operations.[6/]

3/ 47 C.F.R. §§ 15.247 and 15.407.

4/ *Id.* For a period of time, Section 15.247 also allowed for certain U-NII operations, but the Commission consolidated all U-NII rules into Section 15.407. *See Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, 29 FCC Rcd 4127, First Report and Order (2014) ("2014 U-NII Order").

5/ RADWIN does not seek modification of the rules governing the U-NII-2 band because of the limited power permitted in the band.

6/ While RADWIN's technology employs the use of sequential multiple directional beams, the proposed rules follow those in place for 2.4 GHz and would allow for the use of higher power limits by devices that use either simultaneous or sequential multiple directional beams.

The same rationale that the Commission relied upon in adopting the rules in Section 15.247(c) for the 2.4 GHz band applies to unlicensed devices operating with sequential multiple directional beams in the 5 GHz band as well.

B. Modification of the Rules is Consistent with Treatment of 2.4 GHz Broadband Devices.

In 2004, the Commission adopted new rules for unlicensed broadband technologies used in the 915 MHz, 2.4 GHz, and 5.7 GHz bands for the purposes of expanding applications and allowing greater flexibility of use.[7/] The Commission's intent was to "encourage and facilitate an environment that stimulates investment and innovation in broadband technology and services."[8/] In particular, the Commission aimed to remove unnecessary regulatory impediments to deploying advanced technologies for unlicensed wireless networking, including advanced antennas, which the Commission recognized "allow greater re-use of the same radio frequencies."[9/] The Commission noted that the new rules would allow broadband providers to adjust their coverage to their customers, promoting increased broadband access in rural and underserved areas and isolated communities.[10/]

To effectuate those public interest goals, the Commission modified Section 15.247 to allow certain unlicensed devices operating in the 2.4 GHz band that emit sequential multiple directional beams to operate at power limits otherwise applicable to point-to-point systems.[11/] The Commission determined that devices using sequential multiple directional beams could

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7/ *Modification of Parts 2 and 15 of the Commission's Rules for unlicensed devices and equipment approval*, Report and Order, 19 FCC Rcd 13539 (2004) ("Part 15 Order").

8/ *Id.* at ¶ 1.

9/ *Id*. at ¶ 2.

10/ *Id.* at ¶ 3.

11/ *Id.* at ¶¶ 12–15.

operate with an aggregate transmit output power (transmitted simultaneously on all beams) of up to 8 dB above the power limit allowed for individual beams.[12/] And the Commission allowed the total Equivalent Isotropically Radiated Power ("EIRP") for any beam to operate up to the EIRP allowed for conventional point-to-point transmissions.[13/] The Commission explained that these changes would allow for the provision of broadband communications in a spectrally efficient way.[14/]

As part of that rulemaking proceeding, the Commission considered, but ultimately did not adopt, similar rules covering any of the U-NII-bands. In particular, the Consumer Electronics Association ("CEA") (now the Consumer Technology Association) asked that "the Commission extend these same provisions to the other unlicensed bands, including specifically the 5 GHz U-NII bands and the 5.8 GHz unlicensed bands where devices operate that are comparable to those using the 2.4 GHz band and the same benefits could be realized."[15/] CEA noted the benefits of permitting the point-to-point power limits – improvements in the reliability and spectrum efficiency of unlicensed broadband communications devices – and therefore questioned why the Commission's proposal was limited to the 2.4 GHz band. Nevertheless, without providing a rationale, the Commission declined to adopt CEA's proposal, permitting the point-to-point power limits for devices that emit sequential multiple directional beams in the 2.4 GHz band only.[16/] The use of these power limits adopted in 2004 has not affected other 2.4 GHz band or adjacent band operations. Accordingly, it is now time for the Commission to re-examine this

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12/ *Id*. at ¶ 12.

13/ *Id*. at ¶ 13.

14/ *Id.* at ¶ 7.

15/ *Comments of the Consumer Electronics Association*, ET Docket No. 13-201 at Executive Summary (filed Jan 23, 2004).

16/ *See* Part 15 Order at ¶¶ 6–17.

issue and adopt the same approach to sequential multiple directional beams in the U-NII-1 and U-NII-3 GHz bands as it has already has for the 2.4 GHz band.

C. Adoption of the Proposed Rules Will Not Adversely Impact Other Users.

Historically, lower limits on EIRP for point-to-multipoint systems were required because they used widebeam, sectorized antennas, which by definition transmit equally into the entire sector coverage area and therefore introduce potential interference to all devices within that coverage area, regardless of their location with respect to the subscriber unit. Beamforming technology overcomes this limitation and allows for more directional connectivity, providing better service without increasing the risk of harmful interference to other devices in the U-NII-1 and U-NII-3 bands or adjacent bands within the sector coverage area. **Appendix B** demonstrates that the interference generated by point-to-multipoint devices operating with multiple directional beams utilizing beamforming technologies and operating at the power limits of point-to-point devices operating in the same band, would not be higher than the interference generated by legacy point-to-point devices operating with directional antennas or point-to-multipoint devices utilizing legacy sectorized wide-beam antennas. And in many cases, the interference risk would be significantly lower.

D. Adoption of the Proposed Rules is in the Public Interest.

For well over a decade, U-NII devices have been necessary as a means of meeting the public's demand for wireless broadband.[17/] Especially in rural areas, wireless Internet service providers ("WISPs") and carriers have relied upon this unlicensed, mid-band spectrum to provide fixed wireless access services at reasonable cost. The rule changes proposed here would

[17/] 2014 U-NII Order, ¶ 15.

benefit the public by promoting deployment of broadband by allowing for more widespread use of advanced broadband technologies that allow operations in the U-NII-1 and U-NII-3 bands at lower costs (as noted below) thereby advancing the Commission's goal of ensuring access to broadband by all Americans.[18/]

Providing for the enhanced power limits for devices that use sequential multiple directional beams will increase performance and reliability, and reduce deployment costs, of communications systems in the U-NII-1 and U-NII-3 bands. The use of directional signals at higher power levels towards the subscriber units will increase reliability for two reasons – first, because the signals will transmit at higher and more directional power, and second, because there is less potential that the signals will be interrupted. The use of directional beams will ensure that less power is transmitted towards non-desired directions, reducing the likelihood of interference to other devices in the vicinity, as the allowed power will be directed towards the desired receiver. These same benefits will also allow providers to encounter fewer inter-site interference issues to address, simplifying the process of site planning and reducing associated costs.

The rule change will make system deployment more economically attractive because it will allow a service provider to reach more customers from the same hub or base station. Due to the directional higher power transmission, more users could be supported, including more remote users, and all would receive higher throughput and better, more reliable service. Service providers will no longer be faced with the unattractive decision of whether to incur the additional costs associated with deploying additional hub/base stations to reach a limited number of

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[18/] Favorable action in this proceeding will also be consistent with the Commission's recent action to promote the introduction of new technologies by proposing implementation of Section 7 of the Communications Act. *See Encouraging the Provision of New Technologies and Services to the Public*, Notice of Proposed Rulemaking, FCC 18-18 (rel. Feb. 23, 2018) ("Section 7 NPRM").

additional remote customers. The beamforming and multidirectional beam technologies would enable them do so without increasing the risk of interference, enhancing service to end users while not impacting other nearby devices. The result will lead to additional customers receiving service in hard to reach, often rural, areas. And, the rule changes will improve spectrum efficiency because directional beams allow for the use of the same spectrum by hubs located in the same geographic proximity, as the interference potential between sites and co-located sectors is lower.

Improved performance and reliability in fixed access technologies in the U-NII bands will translate directly to enhanced access to broadband in rural communities, which will help to close the digital divide. Policymakers and lawmakers have long recognized the need for better access to broadband in rural and other underserved communities. The U-NII bands are increasingly used by wireless Internet access providers to reach rural communities.[19/] Therefore, by providing systems using U-NII spectrum with the ability to reach more customers at the same cost, or reducing the cost to further extend fixed access systems, the Commission will be taking real steps to help meet the needs of unserved and underserved areas. The Commission determined in 2004 that increased power limits would serve the public interest by promoting broadband access in rural and underserved areas and isolated communities.[20/] Meeting rural broadband needs remains an important policy goal for the FCC. Chairman Pai stated recently, "[f]ar too many Americans still lack access to high-speed Internet, and that's why the FCC's top

19/ *See* Comments of the Wireless Internet Service Providers Association, ET Docket No. 13-49 (filed July 7, 2016) (noting throughout the important of the U-NII bands for rural broadband).

20/ *Part 15 Order*, ¶ 3.

priority under my leadership remains bridging the digital divide and bringing digital opportunity to all Americans."[21/]

In addition to the FCC, lawmakers also strongly support these policy goals. Congress recently passed the 2018 Appropriations Act, which takes numerous actions to encourage broadband deployment in rural areas.[22/] Key provisions include allocating funds for loans and grants for rural telecommunications and broadband;[23/] encouraging equal deployment of the FirstNet national broadband network for first responders in both rural and urban areas;[24/] requiring the FCC to issue a report to Congress within 90 days on the status of call delivery in rural areas;[25/] and requiring the FCC to begin a rulemaking within one year to determine whether licensees should be able to partition or disaggregate spectrum to promote advanced telecommunications in rural areas.[26/] These actions demonstrate the ongoing commitment to improve broadband access to Americans in rural and underserved areas.

Modifying the rules is critical to improving broadband access in rural areas because providing service directly to each home or business located there by fiber or point-to-point wireless technologies is prohibitively expensive. WISPs have relied upon point-to-multipoint solutions (and lately on those employing multiple directional beam technologies) to connect otherwise unconnected communities. As a result, in certain rural areas business are booming and

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21/ Chairman Pai Statement on Draft 2018 Broadband Deployment Report (rel. Jan. 18, 2018).

22/ Consolidated Appropriations Act 2018, Pub. L. No. 115-141.

23/ *Id*. at div. A, tit. III, Rural Electrification and Telecommunications Loans Program Account ($690,000,000 for rural telecommunications loans); div. A, tit. VII, § 779 ($600,000,000 for broadband loans and grants).

24/ 164 Con. Rec. 50,11, H2085 (2018).

25/ *Id* at H2520.

26/ *Id.*

professionals who otherwise would live and work in urban areas are relocating to rural areas because broadband access affords them the opportunity to telecommute. Grant of the requested rule change to allow higher maximum power limits will expand these success stories, permitting ISPs to connect to customers located even greater distances from a hub at no additional cost. Expanded broadband service will bring greater economic benefits to more rural communities.[27]/

Service providers and customers in high-density areas also will benefit from the proposed rule changes. The modified rules will facilitate more efficient spectrum use – allowing a single provider to serve more customers and enable multiple providers to more efficiently use the same spectrum in an area. By making the provision of service more technically attractive, the Commission will enable the provision of service to underserved urban areas.

The rule changes will enhance market competitiveness and the diversity of broadband service providers by enhancing the ability of more providers to use unlicensed spectrum, which does not require a costly license, reducing costs of providing broadband service. This better allows smaller providers to compete with licensed spectrum holders and overall will encourage competition and the provision of higher throughput and more reliable service.

27/ For example, one study found that a 1% increase in broadband creation is associated with the creation of 300,000 new jobs in areas not already at full employment. "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data," The Brookings Institute, Issues in Economic Policy, No. 6, at p.12 (July 2007), available at https://www.brookings.edu/wp-content/uploads/2016/06/06labor_crandall.pdf. And the Internet Innovation Alliance estimated that an average consumer could realize more than $9,000 in savings by having the opportunity to obtain discounts and sales only available online. "10 Ways Being Online Saves You Money," Internet Innovation Alliance (Nov. 21, 2016), available at https://internetinnovation.org/special-reports/savings/?mc_cid=53bf9d2907&mc_eid=7baefb8a20.

III. CONCLUSION

Allowing systems that use sequential multiple directional beam technology in the U-NII-1 and U-NII-3 band to operate at power levels otherwise applicable to point-to-point systems will further the Commission's goal of ensuring access to broadband services in rural America and elsewhere. Accordingly, RADWIN respectfully requests that the Commission adopt rules in accordance with those set out in **Appendix A**.

Respectfully submitted,

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APPENDIX A

Proposed Revisions to the Commission's Rules

Chapter 1 of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

PART 15 – RADIO FREQUENCY DEVICES

Section 15.407 is amended to modify subsections (a)(1)(iii) and (a)(3) as follows:

15.407 General technical requirements.

(a) *Power limits:*

(1) For the band 5.15-5.25 GHz.

***

(iii) . . . . Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information**; provided, however, that devices that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals into individual receivers or groups of receivers may be treated as fixed, point-to-point operations for the purpose of this section**. . . .

***

(3) For the band 5.725-5.85 GHz . . . . Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information; **provided, however, that devices that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals into individual receivers or groups of receivers may be treated as fixed, point-to-point operations for the purpose of this section**. . . .

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APPENDIX B

Technical Statement in Support of Petition for Rulemaking

1 Introduction

RADWIN, LTD. has prepared this Technical Statement in support of its Petition for Rulemaking seeking to amend the Part 15 rules for U-NII-1 and U-NII-3 operations. In particular, RADWIN requests that the Commission allow devices in these bands that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals into individual receivers or groups of receivers to operate under the rules allowed for fixed, point-to-point operations.

Radio devices employing multiple directional beam technologies allow for the transmission of a very directional beam in the direction of each subscriber unit, representing a more efficient use of the spectrum when compared to the use of legacy wide-beam fixed pattern sectorial antennas. Allowing U-NII-1 and U-NII-3 base stations to operate at the same Effective Isotropic Radiated Power (EIRP) limits allowed for point-to-point systems in these bands will not pose any additional risk of interference, as the transmission at any instance resembles that of a point-to-point system. Furthermore, allowing higher EIRP, similar to that of a point-to-point system, would enhance the service experience of remote users, as the signals would travel a longer distance, provide higher throughput, and deliver a more reliable service. This Technical Statement further demonstrates that the use of multiple directional beam technologies at the requested higher EIRP would not introduce a higher level of interference to other U-NII-1 and U-NII-3 devices in proximity, but rather, would lower the level of interference compared to a system using a legacy wide-beam sectorial antenna.

In the following analysis, RADWIN compares the interference generated into the main beam and outside of the main beam by: 1) point-to-point systems using directional antennas; 2) point-to-multipoint systems using wide-beam sectorial antennas; 3) and point-to-multipoint systems using multiple directional beam antennas – each operating at the allowable Section 15.407 EIRP limits for the U-NII-3 band for both point-to-point and point-to-multipoint operations.

2 Analysis Assumptions

For the analysis, we consider three RADWIN products operating in the 5.8 GHz U-NII-3 band:

1. A point-to-point radio (model RW-2050-D100), which has an integrated 1 foot flat panel directional antenna with a 23 dBi antenna gain (*see* antenna pattern demonstrated in Figure 1).
2. A point-to-multipoint base station (model RW-5200-0250), which is connected to a 1.6 x 1 foot flat panel 90 degree sectorial (fixed pattern) antenna that has a 15 dBi antenna gain (*see* antenna pattern demonstrated in Figure 2).
3. A point-to-multipoint base station (model RW-5BG5-0650), which has an integrated flat panel multiple directional beam antenna that provides 90 degrees of coverage and that, using beamforming and steering technology, transmits a directional beam in the direction of a specific subscriber unit with a gain of 20 dBi (*see* directional antenna pattern demonstrated in Figure 3, assuming that the subscriber unit is located at zero degrees azimuth).

All three radios are FCC-certified for operation in the U-NII-3 band and are capable of transmitting up to 25 dBm power (without the antenna). The following analysis considers and compares the interference each of these three radios generates into nearby victim receivers.

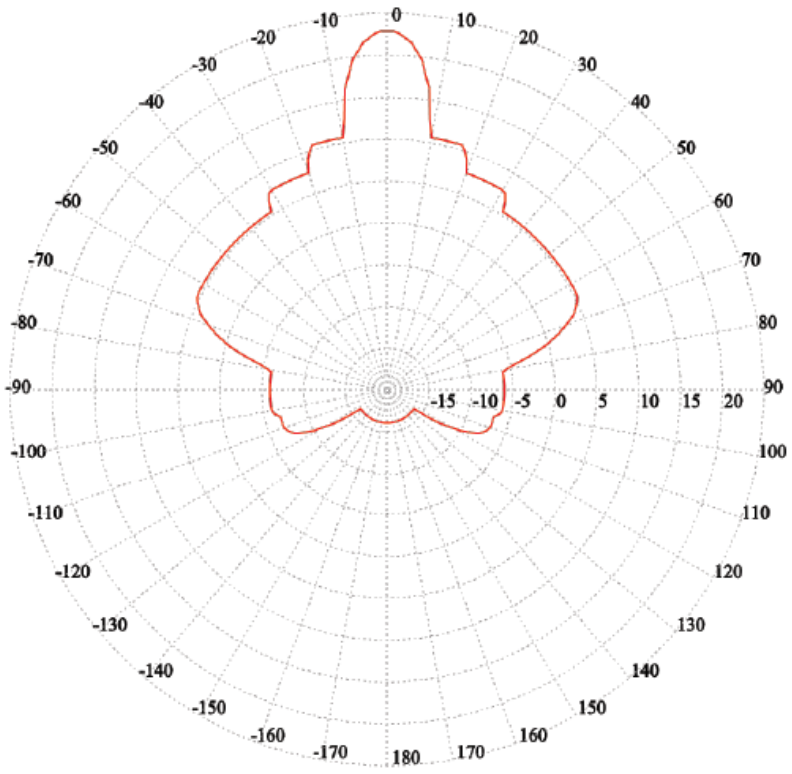

Figure 1 Directional antenna pattern (model RW-2050-D100)

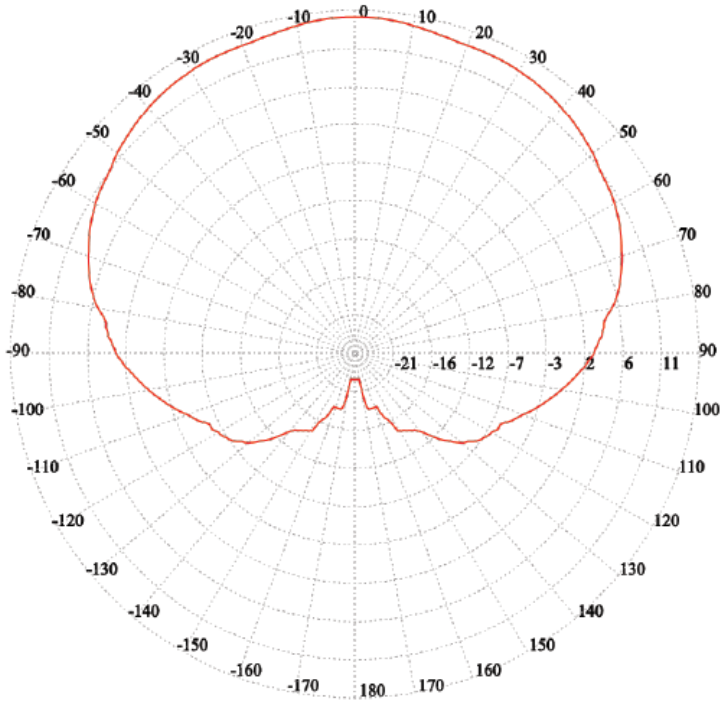

Figure 2 90-degree fixed pattern sectorial antenna (model RW-5200-0250)

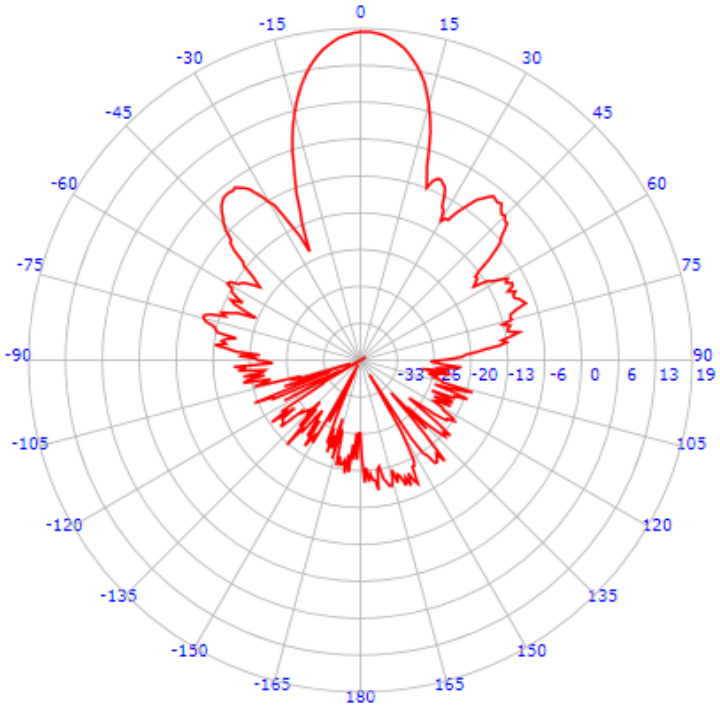

Figure 3 Multidirectional beamforming radiation pattern (set to azimuth 0) (model RW-5BG5-0650)

3 Analysis

3.1 Interference Modelling

The interference signal generated by a radio transmitter consists of the antenna radiation pattern and the radio transmission power.

Figure 4, below, depicts the radiation pattern of the three antennas on the same scale.

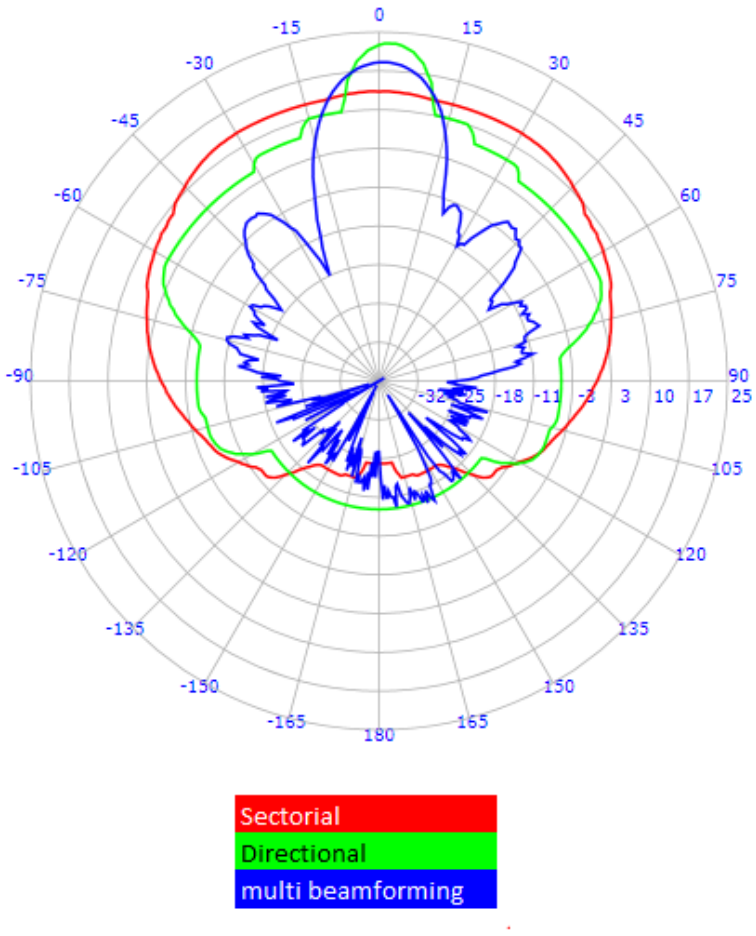

Figure 4 Radiation patterns

By examining the three antenna patterns, we can conclude at first the following:

1. When comparing the fixed pattern sectorial antenna with the directional antenna, it is clear that while the directional antenna creates a greater level of interference (up to 9 dB) within the main beam, the sectorial antenna generates a greater level of interference within a wider directional angle (*i.e.*, 9^0-135^0 and -135^0- -9^0).
2. When examining the multiple directional beam antenna radiation pattern, it is clear that the multiple directional beam antenna radiation pattern is much more similar to that of the directional antenna pattern and different from the fixed pattern sectorial antenna.

In the next analysis, we compare the interference generated under each of the following scenarios:

1. The point-to-point radio transmitting at 25 dBm with a 23 dBi directional antenna (*i.e.*, EIRP=48 dBm), in compliance with the FCC Section 15.407(a)(3) rules for point-to-point operations.
2. The point-to-multipoint base station with a fixed pattern sectorial antenna transmitting in compliance with Section 15.407(a)(3) rules for point-to-multipoint operations (*i.e.*, EIRP=36 dBm).
3. The point-to-multipoint base station with a multiple directional beam antenna transmitting in compliance with Section 15.407(a)(3) rules for point-to-multipoint operations (*i.e.*, EIRP=36 dBm).
4. The point-to-multipoint base station with a multiple directional beam antenna transmitting if allowed to comply with Section 15.407(a)(3) rules for point-to-point operations, which has a transmission power of 25 dBm and an antenna gain of 20 dBi (*i.e.*, EIRP=45 dBm).

Figure 5 depicts the interference created by each of the above scenarios.

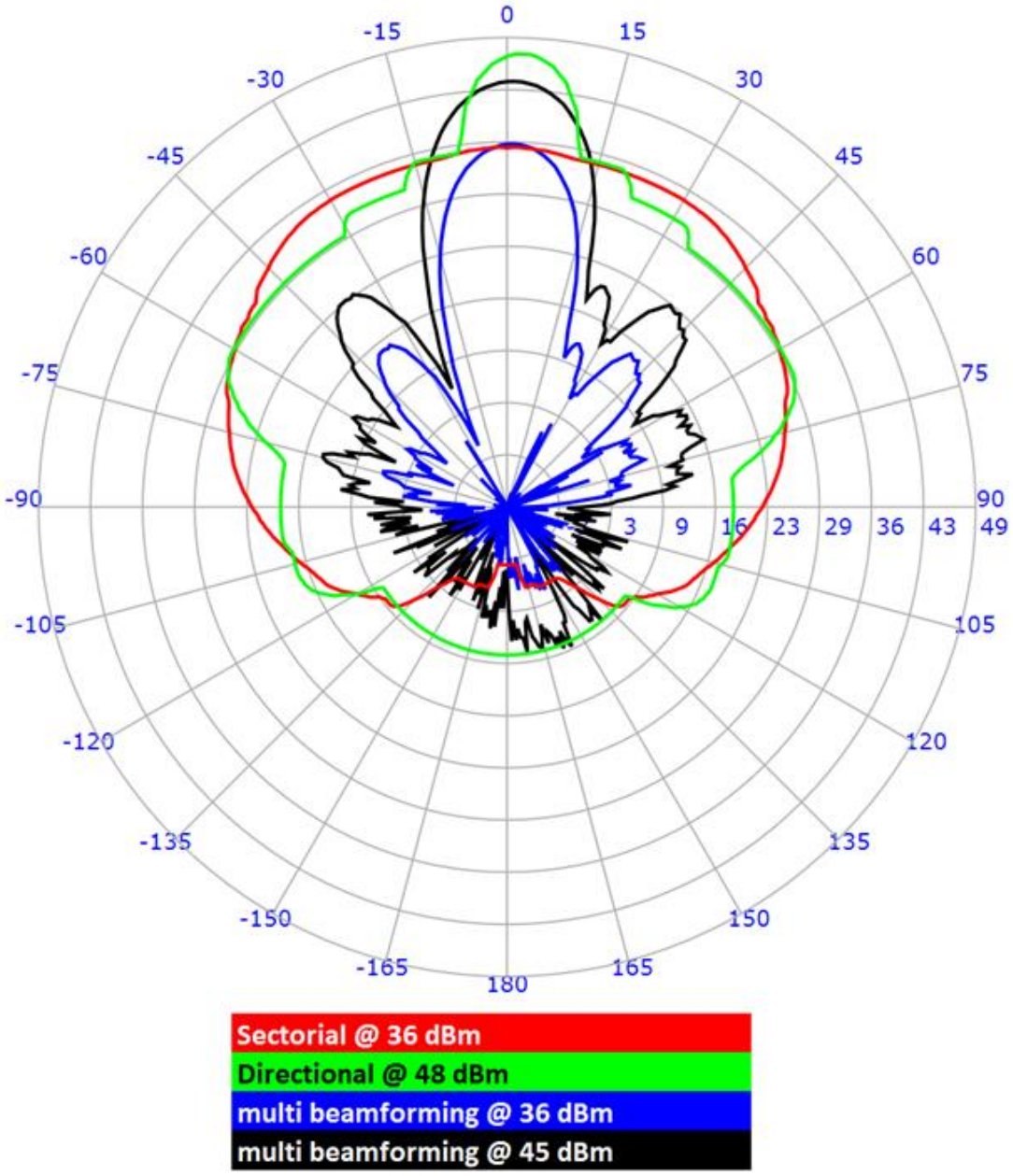

Figure 5 Interference pattern for all use case scenarios

3.2 Interference Outside of the Main Lobe

In this section, we analyze and compare the interference generated outside of the main lobe under each of the four scenarios outlined above. We assume that the main beam transmits at a width of 20 degrees (-10deg to 10deg). We calculate the interference generated outside of this main beam for 360 degrees around the transmitter, located at distance zero (which represents the worst-case average interference per each scenario). Equation 1 calculates the average level of interference generated in all directions for each of the four scenarios, measured at a distance of zero outside of the main beam.

Equation 1 Average interference outside of the main beam

$$10 \times log_{10}\left(\frac{\sum_{i=10}^{350} 10^{\left(\frac{P_{dBm}(i)-30)}{10}\right)}}{340}\right)+30$$

Where P_{dbm} *(i)* is the interference generated in direction i.

The results are summarized in Table 1:

Table 1: Average Interference per Scenario Outside of the Main Beam

Scenario #	Radio and Antenna	EIRP calculation (dBm)	Average interference 10-350 degrees (dBm)[1]
1	PtP radio with directional antenna	48	28
2	PtMP base station with sectorial 90deg antenna	36	30
3	PtMP base station with beamforming antenna, under current PtMP EIRP rules	36	17
4	PtMP base station radio with beamforming antenna, under proposed use of PtP EIRP rules	45	25

Conclusions on interference outside of the main beam under each of the four scenarios:

1. Being non-directional, and despite the EIRP limitations, the legacy point-to-multipoint base station with the sectorial 90 degrees antenna generates the highest levels of interference and always creates more interference than the same point-to-multipoint base station operating with a multiple directional beam antenna, even when the latter operates at the higher EIRP requested in the Petition for Rulemaking (*i.e.*, the EIRP allowed for point-to-point operations).
2. The point-to-multipoint base station with multiple directional beam technology does not generate higher interference levels than a point-to-point base station operating with a directional antenna, even if the former is allowed to operate at the higher EIRP level requested in the Petition for Rulemaking (*i.e.*, the EIRP allowed for point-to-point operations).
3. The point-to-multipoint base station when using a multiple directional beam antenna generates the least amount of interference to nearby receivers even when operated at the EIRP level requested in the Petition for Rulemaking (*i.e.*, the EIRP allowed for point-to-point operations) when compared to point-to-point base stations using directional antennas or point-to-multipoint base stations using wide-beam sectorial antennas.

[1] Interference at distance = 0

3.3 Interference within the main lobe

In this section, we compare the interference generated inside the main beam under all four scenarios. We assume that the main beam transmits at 20 degrees (-10deg to 10deg). The main beam represents the desired direction of the transmitter.

For the first two scenarios (point-to-point operations using a directional antenna and point-to-multipoint operations using a wide-beam sectorial antenna, both operating under current EIRP limits) the interference level generated inside the main beam is constant and equal to the EIRP of each transmitter (*i.e.*, 48 dBm for the point-to-point scenario and 36 dBm for the point-to-multipoint scenario).

Under the scenario of the base station operating with a multiple directional beam antenna, where the antenna is electronically steered towards the relevant subscriber unit in a TDMA mode, and per transmission slot, the strong transmission in the specific "interfered" direction is limited to the amount of time the antenna is steered in that direction. Assuming that the subscriber units are uniformly distributed within 90 degrees of the sector coverage, the average level of interference created in any specific direction (0 degrees in the example below) is calculated using the following Equation 2:

Equation 2 Average interference inside the main beam

$$10 \times log_{10}\left(\frac{\sum_{i=-45..45} 10^{\left(\frac{P_{dBm}(i)-30)}{10}\right)}}{90}\right) + 30$$

Where in this case $P_{dbm}(i)$ is the interference generated towards direction 0^0 while the antenna is steered towards direction i^0. The results are provided in the below Table 2.

Table 2: Average Interference Level per Scenario (Inside the Main Beam)

Scenario #	Radio and Antenna	EIRP calculation (dBm)	Average interference within the main lobe (dBm)[2]
1	PtP radio with directional antenna	48	48
2	PtMP base station with sectorial 90deg antenna	36	36
3	PtMP base station with beamforming antenna, under current PtMP EIRP regulation	36	28
4	PtMP base station with beamforming antenna, under proposed PtP EIRP regulation	45	37

[2] Interference at distance = 0e

Conclusions regarding the interference level inside the main beam:

1. The point-to-multipoint base station using a multiple directional beam antenna generates less interference to other receivers located inside the main beam as compared to the point-to-point base station operating with a directional antenna, even when operating under the higher EIRP proposed in the Petition for Rulemaking. This is due to the steering feature of the radio.
2. The point-to-multipoint base station operating with a multiple directional beam antenna, even when allowed to operate at the EIRP level proposed in the Petition for Rulemaking (*i.e.*, the EIRP limit for point-to-point operations) generates a similar level of interference to the much lower EIRP point-to-multipoint operations presently allowed (using a wide-beam sectorial antenna).

The above comparison also demonstrates that allowing point-to-point EIRP limits for point-to-multipoint base stations using multiple directional beam antennas would not introduce a higher level of interference than the level of interference introduced by point-to-multipoint base stations using regular sectorial wide-beam antennas under the lower EIRP limits, and in some cases, would even present a lower level of interference.

Moreover, allowing the higher EIRP requested in the Petition for Rulemaking may further reduce the level of interference inside the main beam due to the use of the multiple directional beam antenna. Furthermore, allowing a higher EIRP limit for technologies using multiple directional beams enables the base station to transmit to any remote subscriber unit at higher modulations. As an example, increasing the EIRP limit as requested in the Petition for Rulemaking (from the current limited 36 dbm to 45 dbm) will add 9 dbm to the signal strength, allowing an increase in the modulation by 2-3 rates. This increase in modulation translates directly to higher bit rate and higher throughput in the direction of each subscriber unit, which means that the antenna would need to be steered in the direction of each subscriber unit for a shorter amount of time to deliver the same service.

For example, in the case of the RADWIN radio:

MCS – modulation scheme	Gross bit rate	Receiver sensitivity threshold
64 QAM K=3/4 @ 80 MHz	585 Mb/s	-63 dBm
256 QAM K=5/6 @ 80 MHz	866.7 Mb/s	-56 dBm

The difference between the modulations in the example is 7 dB. This means that the same traffic can be communicated at a bit rate 25% faster, limiting the time the antenna would steer into each subscriber unit, therefore reducing the interference in that (main lobe) direction by same ratio. This results in a reduction of the interference level inside the main beam by an additional 2 dB.

4 Conclusion

This Technical Statement demonstrates that allowing point-to-multipoint base stations using multiple directional beam antennas to operate at the Section 15.407 EIRP limits allowed for point-to-point devices operating in the same band does not increase the level of interference to other devices operating in these bands. Base stations employing multiple directional beam antennas and operating at the EIRP levels allowed under Section 15.407 for point-to-point systems in the U-NII-1 and U-NII-3 bands

introduce the lowest level of interference compared to the interference introduced by point-to-point systems using directional antennas and operating under the Section 15.407 EIRP limits for point-to-point operations, or by point-to-multipoint systems operating with wide-beam sectorial antennas operating under the Section 15.407 EIRP limits for point-to-multipoint operations. Therefore, not only will the adoption of the proposed higher EIRP limits for multiple directional beam technologies benefit service providers by enabling them to extend the reach of their base stations, enabling the connectivity to further remote subscribers, the proposed rule change would also reduce the overall level of interference to other devices in the U-NII-1 and U-NII-3 bands compared to operations presently allowed under the rules. For this reason, this standard should be adopted.

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